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(54) Title: A PROCESS AND A COMPOSITION TO IMPROVE THE COMBUSTION OF FUELS

(57) Abstract

A process and a composition for improving the combustion of fuels for the generation of energy with reduced corrosion and lowered deposition on heat-transferring and other surfaces, the combustion zone being supplied with a c containing at least the elements Al, Mg, Mn and Zn in a quantity active for efficient combustion.

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A Process and a Composition to Improve the Combustion of Fuels.

The present invention relates to a process to improve the combustion of fuels for the generation of energy, which process operates with reduced corrosion and lowered deposition on heat-transferring and other surfaces. The invention also includes a composition to carry out said process in practice.

Synchronously with increased costs for energy generation, particularly in view of increasing crude oil prices, the techniques to make the combustion of fuels for energy generation more effective has come more and more into focus.

Several systems for improved fuel economy have been developed lately and among those there may be mentioned systems based on bringing into the combustion zone agents intended to reduce the formation of soot, slag deposits on heat-transfer surfaces, corrosion on such surfaces etc. Among such agents there may be mentioned compositions containing different types of phosphates, magnesium compounds slurried in organic carriers etc. Moreover, it has been suggested in connection with combustion of thick fuel oil to emulsify water in the oil, which has been regarded to result in a more economic and improved combustion while reducing the formation of soot and reducing deposits.

Thus, it is desired in connection with combustion of fuels of different types for energy generation to reduce the emission of dust, to reduce discharge of polyaromats, the corrosive effect of the combustion gases on heat-transfer and other surfaces and to reduce deposition of slags and other products on said surfaces. Common to all measures hitherto proposed for the purpose of improving the combustion efficiency and to reduce the

inconveniences resulting from the combustion, seems to be the fact that no scientific approach has been taken which means that with any known system one has not been able to obtain optimization of the combustion conditions and minimizing the negative effects of the combustion. Particularly in view of the present strict environmental requirements it is therefore desirable with a fundamentally new technique by which a more effective combustion of different fuels can be obtained at the same time as one avoids or at least reduces the inconveniences in the form of slag deposits, corrosion etc. arising in connection with the combustion.

When burning fuels for energy generation the oxygen of the air reacts with the substances of the fuel while forming oxygen-containing compounds. The main reactions which are involved are in principle the following:

$$C + 1/2\ O_2 - CO \qquad (1)$$

$$CO + 1/2\ O_2 - CO_2 \qquad (2)$$

$$CO + H_2O - CO_2 + H_2 \qquad (3)$$

$$H_2 + 1/2\ O_2 - H_2O \qquad (4)$$

$$S + O_2 - SO_2 \qquad (5)$$

$$SO_2 + 1/2\ O_2 - SO_3 \qquad (6)$$

The invention has for its purpose to control said reactions so as to result in a more complete combustion, whereby the excess of air and the soot formation and discharge of polyaromats are reduced. In regard to sulphur-containing fuel it is noted that it is desirable to suppress the oxidation of the sulphur dioxide to sulphur trioxide, the latter together with the water of the exhaust gases forming sulphuric acid resulting in non-desirable corrosion. The dew point for sulphur trioxide is, in a manner known per se, dependent on the sulphur trioxide contents of the gases and the carbon dioxide content. The dew point diminishes with sinking sulphur trioxide content and with increasing carbon

dioxide content. Thus, it is essential to suppress the formation of sulphur trioxide and to increase the content of carbon dioxide in the combustion gases.

The technique of the instant invention is based on the one hand the insight of these basic reactions in connection with the combustion, on the other hand the components present in the fuel including contaminants. In connection with the creation of the invention it has been found that a more efficient combustion and an optimized control of the basic chemical reactions in connection herewith can be obtained if it is provided for to supply to the combustion zone a catalyst containing at least the elements aluminium, magnesium, manganese and zinc. A particular feature of the technique of this invention is the adaptation of the dosage of the said elements after the inherent contents of the fuel of said elements. As an example there can be taken a heavy fuel oil containing magnesium. When burning such fuel oil the contents of magnesium of a catalyst composition can be reduced in the corresponding degree as the inherent content of magnesium of the fuel oil. An example to the contrary is a diesel engine fuel not containing zinc, where adding an organic zinc compound results in improved combustion and reduced corrosion.

The technique of the present invention is in general applicable to most fuels, i.e. gasecus, liquid and solid fuels. Moreover, the form of additive according to the invention may vary, inter alia in considering the fuel in question. Thus, the additive can be present in liquid form, preferably an aqueous solution, in powder form, in the form of a slurry of powder in liquid or in other solid form.

The composition according to the invention can be supplied to the combustion zone in several ways, also in this case dependent on the fuel and the practical

situation in question. Thus, the composition can be admixed with the fuel before its supply into the combustion zone, it can be admixed with the air of combustion and, finally, it can be injected directly into the flame or into the combustion space in connection thereto.

In addition to the elements previously mentioned intended for supply to the combustion zone, i.e. aluminium, magnesium, manganese and zinc, one or several of the following elements may be added for the purpose of further improving the combustion conditions and the other conditions in connection with the combustion: cadmium, iron, tin, silicon, beryllium, copper, chromium, silver, barium, titanium, nickel, calcium, molybdenium rubidium, vanadium, sodium, arsenic, boron, bromine, phosphorus and selenium.

The elements involved can be supplied to the combustion zone in varying quantities, from the order of some tenths of ppm based on the quantity of fuel. These added quantities refer to each and every element per se.

The present invention is particularly suited for application in connection with the combustion of liquid fuels, in particular so-called heavy oils for energy generation on a large scale. In this case the additive is suitably added as an aqueous solution containing soluble salts of the elements in question. Such aqueous solutions of the active elements can be supplied to the combustion zone in several ways.

In a preferred embodiment of this aspect of the invention the aqueous solution is supplied to the fuel before the combustion and is emulsified therein in accordance with conventional technique. This results in the advantage that in addition to the positive effect of the active elements on the course of combustion there is obtained also a positive effect on the combustion due

to the added water. The aqueous solution can be supplied to the combustion zone in a quantity of up to about 5 % by volume based on the volume of the fuel, and up to said upper limit the evaporization of the water constitutes an acceptable additional consumption of energy. A particularly preferred quantity of additive in the form of an aqueous solution is about 0.5 - 2 % by volume. The concentration of the active element of the additive is adapted so that in supplying the aqueous solution in the relevant quantity to the combustion zone the said element is supplied in a quantity of the order of up to some tenths of ppm based on the quantity of fuel.

As indicated earlier the present invention also covers a composition to improve the combustion of fuels for energy generation, reduced corrosion and deposition on heat-transferring and other surfaces being obtained. This composition includes at least the elements aluminium, manganese and zinc and dependent on the contents of trace elements of the fuel the composition may contain also magnesium. This composition can be in liquid form, in the form of a powder, in the form of a slurry of solid material in liquid or in another solid form. For burning liquid fuels it is preferably in the form of an aqueous solution containing soluble salts of the said elements. In order to facilitate the admixture of the composition into liquid fuels, which is a preferred embodiment of the invention, the composition may also contain an emulsifier.

When using the technique according to the present invention substantial advantages are obtained in connection with the combustion. Thus, the supply of the elements to the combustion zone means a more complete combustion, the oxidation of the sulphur dioxide to sulphur trioxide will be suppressed, and protection against corrosion within a broad temperature range will

also be obtained. The combustion can be performed with a decrease of the excess of air, which, of course, is favourable both with regard to the coefficient of utilization and also reduces the formation of sulphur trioxide. A low excess of oxygen also, of course, results in an increased content of carbon dioxide which, as previously indicated, means lowered dew point for sulphur trioxide.

The invention will now be described by non-limiting examples.

Example 1.

A fuel oil low in sulphur and of the heavy oil type is analyzed and is found to contain 5 ppms iron, 3 ppms lead, 4 ppms nickel and 25 ppms vanadium. The contents of the elements Mn, Mg, Al and Zn are less than 1/2 ppm.

As an additive there is used an aqueous solution of manganese sulphate, magnesium sulphate, aluminium sulphate and zinc sulphate. The additive is dosed in a quantity of about 1/2 percent by volume based on the quantity of fuel oil, and the concentration of the aqueous solution of the elements in question is adjusted so that the fuel oil is supplied with 10 ppms of manganese, 5 ppms of magnesium, 5 ppms of aluminium and 10 ppms of zinc, all based on the quantity of fuel oil.

The fuel oil is supplied to a boiler of a conventional type having one (1) burner and a capacity of up to about 8 tons of steam per hour. This boiler is normally operated with an excess of air of 30-50 % and an exhaust gas temperature of 250-300°C. When the boiler is operated in accordance with the technique of the present invention, i.e. while adding the aqueous solution described above containing the elements in question to the fuel oil, the exhaust gas temperature can be lowered down to about 200°C and the excess of air can be reduced to about 20-30 %.

These operational changes when applying the technique according to the present invention results in substantially improved efficiency of utilization in the combustion, reduced deposition on the heat-transferring surfaces of the boiler and substantially reduced corrosion.

Example 2

The procedure according to Example 1 is repeated but using a fuel oil which, according to analysis performed, contains magnesium in an amount of about 3 ppms. Against this background the procedure of Example 1 is repeated but while using an additive not containing magnesium sulphide but only the remaining three elements in the same quantities. The same favourable results as in Example 1 are obtained in operating the boiler in regard to excess of air and exhaust gas temperature and other operational conditions. Moreover, by the adjusted process according to the invention overdosage of magnesium is avoided which otherwise by deposition on heat transferring surfaces will impair the heat transfer.

Example 3

An extended test was performed on a boiler provided with four pressurized air burners and a maximum steam capacity of 75 tons per hour. The fuel used which was a fuel oil low in sulphur and of the heavy oil type was analyzed with regard to trace elements. A representative sample from the oil stock containing a one year consumption contained inter alia 6 ppms of zinc, 5 ppms of Fe, 4 ppms of Mg, 16 ppms of Ni, 33 ppms of V. The contents of Mn and Al were less than 1/2 ppm.

The additive in this case was an aqueous solution consisting of $MnSO_4$ and $Al_2(SO_4)_3$ and the dosage was performed in the same manner as above. The sweeping frequency was reduced from once/day to once every fourth

day and in spite of this the exhaust gas temperature during the sweeping intervals sank by 5-10°C on average. The exhaust gas temperature could be further reduced by 5-10°C by increased heat recovery without the formation of sulphuric acid condensate. The pH of ashes in the dust collectors increased from about 1.5 to about 3.5. The previous disturbing high and low temperature corrosion was gone. The contents of unburnt residues in ashes and exhaust gases were practically nil.

It should be observed that the present invention is not delimited to merely energy generation while using liquid fuels in accordance with the examples. Thus, the invention is applicable also to firing solid fuels, such as coal, coke, chips, turf, solid waste, etc., and the additive according to the invention can be supplied to the air of combustion in atomized form or be dosed directly onto the solid fuel, the active elements remaining in the combustion zone, for example after the evaporization of the water if the additive is an aqueous solution.

When firing using gaseous fuels the additive according to the invention can be supplied to the combustion zone by atomization and supplied to for example supplied air or directly to the gaseous fuel.

CLAIMS

1. A process for improving the combustion of fuels for the generation of energy with reduced corrosion and lowered deposition on heat-transferring and other surfaces, characterized by supplying to the combustion zone a catalyst containing at least the elements Al, Mg, Mn and Zn in a quantity active for efficient combustion.

2. A process according to claim 1, characterized by adapting the dosage of the said elements after the inherent contents of the fuel of said elements.

3. A process according to claim 1 or 2 for the combustion of liquid fuels, particularly so-called heavy oils, characterized by maintaining said elements dissolved in an aqueous solution which is supplied to the combustion zone.

4. A process according to claim 3, characterized thereby that the fuel is supplied to the aqueous solution before combustion and is emulsified therein.

5. A process according to claim 3 or 4, characterized by supplying the aqueous solution to the combustion zone in a quantity of up to about 5 % by volume based on the volume of the fuel.

6. A process according to claim 5, characterized by supplying the aqueous solution in an amount of about 0.5 - 2 % by volume.

7. A process according to any preceding claim, characterized thereby that each of the said elements are supplied in a quantity of the order of magnitude of up to some tenths of ppms based on the quantity of fuel.

8. A composition for improving the combustion of fuels for the generation of energy with reduced

corrosion and lowered deposition on heat-transferring and other surfaces, characterized thereby that it contains at least the elements Al, Mn and Zn.

9. A composition according to claim 8, characterized thereby that it is in the form of an aqueous solution.

10. A composition according to claim 8 or 9, characterized by containing also Mg.

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE81/00309

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

C 10 L 1/12, 10/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	C 10 L 1/00,10,12, 9/00,02,06,10,12, 10/00-06, F 23 J 15/00
US Cl	44:4-6

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	SE, C, 108 848 (D I E CARLSON) 26 October 1943	1, 8
Y	CH, A, 202 497 (J B TOUSTON) 17 April 1939, see example 2	1-10
Y	FR, A5, 698 152 (PATENT FUELS & COLOR CORPORATION) 28 January 1931, see résumé 1 d	1, 8
Y	GB, A, 485 333 (M POURBAIX) 18 May 1938	1-10
X	GB, A, 1 005 957 (CARBORUNDUM CO) 29 September 1965, see claim 1	1-10
Y	DE, A1, 2 407 508 (VEB BERGMANN-BORSIG GORLITZER MASCHINENBAU) 16 January 1975, see claim 8	1-10

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* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1982-01-05	1982-01-12
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Mårten Hulthén

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
Y	DE, A1, 2 648 741 (TSCHIKUL ET AL) 3 May 1978, see claim 1-2	1-10
X	DE, A1, 2 938 074 (ATLANTIC RICHFIELD CO) 3 April 1980, see claim 4	1-10
X	EP, A1, 13 243 (CALGON CORP) 9 July 1980, see claim 1 a	1-10
X	US, A, 3 332 755 (APOLLO CHEMICAL CORP) 25 July 1967, see column 2 lines 31-32	1-10
X	US, A, 3 692 503 (APOLLO CHEMICAL CORP) 19 September 1972, see column 21 lines 63-67	1-10